(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 989 629 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.03.2000 Bulletin 2000/13

(51) Int Cl.[7]: **H01Q 9/36**

(21) Application number: **99402141.8**

(22) Date of filing: **27.08.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **01.09.1998 JP 24681498**

(71) Applicant: **Nippon Antena Kabushiki Kaisha**
Tokyo 116 (JP)

(72) Inventors:
- **Seki, Kouichi**
  Warabi-shi, Saitama 335 (JP)
- **Kamiya, Akio**
  Warabi-shi, Saitama 335 (JP)

(74) Representative: **Blot, Philippe Robert Emile et al**
c/o Cabinet Lavoix,
2, place d'Estienne d'Orves
75441 Paris Cedex 09 (FR)

(54) Vehicular antenna

(57) The present invention has as an object the storing of a GPS antenna portion and a telephone antenna portion inside a compact antenna case, and is constituted as follows. A GPS antenna portion 4 is housed inside a GPS antenna storage portion 3b formed in an elliptical metal base 3. A telephone antenna portion 5 is constituted from an element portion, and a circular top load portion, which is disposed at the tip of the element portion, and which is bent downward to form an umbrella shape. Because the top load portion is bent downward, the capacity generated between the top load portion and the metal base 3, which acts as the ground plane, is large, and the diameter of the top load portion can be shortened. In accordance therewith, it is possible to make the shape of the telephone antenna portion 5 smaller, and to store same inside an antenna case, comprising a cover 2 and the metal base 3.

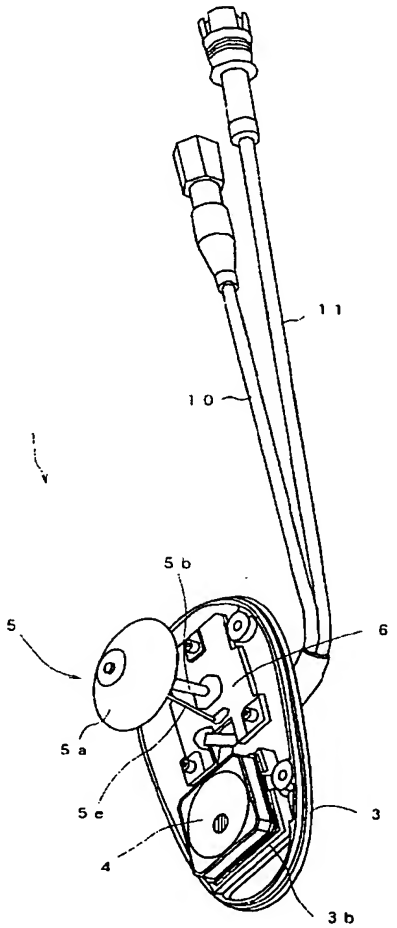


FIG. 3

EP 0 989 629 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a vehicular antenna capable of either transmission and reception, or reception in the car phone band and GPS band, and more particularly to a vehicular antenna well-suited for use as a roof antenna, which is mounted to the roof of a vehicle.

2. Description of the Related Art

[0002] There are a variety of antennas that can be mounted to a vehicle, but since mounting an antenna to the roof, which is the highest point on a vehicle, can enhance receptivity, the roof-mounted roof antenna has been preferred for some time. Further, car navigation systems that make use of the global positioning system (GPS), and car phones have become popular recently, and there is demand for equipping vehicles with a GPS antenna used with a car navigation system, and a telephone antenna used with a car phone.

[0003] Now, since installing each of a plurality of types of antennas separately on a vehicle causes problems from the standpoint of design, and also makes installation work and maintenance complicated, a vehicular antenna, which provides a car phone antenna portion and a GPS antenna portion in a single antenna case, is desirable.

[0004] An example of the constitution of this type of vehicular antenna is shown in Fig. 14. The vehicular antenna 100 shown in Fig. 14 comprises a GPS antenna 104, which receives GPS signals, and a telephone antenna 105, which is used by a car phone. These 2 types of antennas are installed in an antenna case comprising a conductive metal base 103, and a synthetic plastic cover 102, which is attached by fitting same together with this metal base 103. Furthermore, the telephone antenna 105 is a rod-shaped antenna, and is screwed into a mounting portion of the cover 102. Then, the telephone antenna 105 is electrically connected to a circuit board 106, which incorporates a matching circuit. Further, the GPS antenna 104 is housed inside a storage portion formed in the metal base 103.

[0005] However, in the above-described vehicular antenna 100, because the rod-shaped telephone antenna 105 is provided in a standing condition relative to the cover 102, the overall height is high. Consequently, mounting this vehicular antenna 100 to a vehicle can cause problems from the standpoint of design, and can cause problems from the standpoint of operation. Further, it gives rise to the danger of the protruding telephone antenna 105 being bent or broken off by an obstacle.

[0006] Now then, to make the vehicular antenna 100 shown in Fig. 14 smaller, the rod-shaped telephone antenna 105 can be made smaller. One method that comes to mind for making the telephone antenna 105 smaller is to use the helical antenna 110 shown in Fig. 15 as a telephone antenna 105.

[0007] However, if the antenna height H2 of a helical antenna 110 is held in check, antenna impedance decreases, making it difficult to achieve a match with the electric supply line, thus prohibiting antenna height H2 from being lowered too much. Actually, if the wavelength of the targeted frequency is treated as λ, an antenna height H2 of around $3\lambda/16$-$\lambda/4$ is required, indicating that the helical antenna 110 cannot be made too small.

[0008] Furthermore, if the antenna height H2 of a helical antenna 110 exceeds $3\lambda/16$, the voltage standing wave ratio (VSWR) characteristics thereof constitute the characteristics shown as "Conventional" in Fig. 12, and the operable frequency range F1 is narrowband, thus making it unsuitable as a telephone antenna, which requires broadband. And furthermore, if the antenna height H2 of a helical antenna 110 is less than $3\lambda/16$, the VSWR characteristics thereof constitute the characteristics shown as "Conventional" in Fig. 13. That is, the VSWR is 3 or larger, causing antenna gain to decrease greatly.

[0009] Further, one method that comes to mind for making a telephone antenna 105 smaller is to use a top-loaded antenna 120 shown in Fig. 16 (a), (b) as a telephone antenna 105. This top-loaded antenna 120 constitutes an element portion 120b, which is arranged in a standing condition perpendicular to a substrate 120c, and a circular top load portion 120a which is provided at the end of the element portion 120b. In accordance with providing the top load portion 120a at the end of the element portion 120b, it is possible to keep the antenna height H3 of the top-loaded antenna 120 low. Also, antenna impedance does not decrease, and matching can be readily achieved. However, when the antenna height H3 is lowered to where the top-loaded antenna 120 can be housed inside a cover 102, the diameter D5 of the top load portion 120a increases, requiring an antenna case with a large internal volume. In the end, the vehicular antenna 100 cannot be made smaller.

[0010] Accordingly, an object of the present invention is to provide a compact vehicular antenna, which is capable of storing a GPS antenna portion and a telephone antenna portion inside a compact antenna case.

SUMMARY OF THE INVENTION

[0011] To achieve the above-mentioned object, the vehicular antenna of the present invention comprises a telephone antenna portion capable of receiving radiotelephony bands; a circuit board, which is equipped at the least with matching means, and to which this telephone antenna portion is mounted in a fixed condition; a GPS antenna portion; a conductive base; and a cover, which is attached by fitting same together with this base, and

comprises an antenna case, inside which the above-mentioned telephone antenna portion, the above-mentioned circuit board, and the above-mentioned GPS antenna portion are stored, and the above-mentioned telephone antenna portion is constituted from an element portion, and a top load portion, which is disposed at the end of this element portion, and which is bent downward.

[0012] Further, with the above-described vehicular antenna, the above-mentioned top load portion can be configured as a downward sloping umbrella shape, or can be bent more than once so that the end portion of the above-mentioned top load portion forms a rough orthogonal, or the above-mentioned top load portion can be configured as a frame-only skeleton constitution. Furthermore, one end of the element portion can be connected to a prescribed location on the above-mentioned element portion, while the other end of the grand plane is provided with a matching stub connected to a ground, and a compacting coil is inserted in the above-mentioned element portion.

[0013] According to a present invention such as this, the storing of a GPS antenna portion and a telephone antenna portion inside an antenna case enables the realization of a vehicular antenna, which lacks a protruding element section, and also enables the realization of a vehicular antenna which will not be broken off or bent by an obstacle.

[0014] Further, because the top load portion of the telephone antenna portion is bent downward, the space between the top load portion and the ground plane is narrowed, thereby increasing the capacity resulting from the top load portion and the ground plane. In accordance therewith, since the diameter of the top load portion can be kept small. the antenna height can be lowered, and a compact telephone antenna portion can be achieved.

[0015] In this manner, with the vehicular antenna of the present invention, it becomes possible to store a telephone antenna portion inside a compact antenna case, and the overall size of the vehicular antenna can be made small, thereby eliminating to the utmost problems from the standpoint of design when the vehicular antenna is mounted to a vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a top view, plan view showing the constitution of an aspect of the embodiment of the vehicular antenna of the present invention;

Fig. 2 is a diagram showing a breakout plan view of the constitution of an aspect of the embodiment of the vehicular antenna of the present invention;

Fig. 3 is a diagram showing an oblique view of an aspect of the embodiment of the vehicular antenna of the present invention with the cover removed;

Fig. 4 is a diagram showing an example of a first constitution of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention;

Fig. 5 is a diagram showing an example of a second constitution of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention;

Fig. 6 is a diagram showing an example of a third constitution of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention;

Fig. 7 is a diagram showing an example of a fourth constitution of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention;

Fig. 8 is a diagram showing an example of a fifth constitution of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention;

Fig. 9 is a diagram showing an example of a sixth constitution of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention;

Fig. 10 is a diagram showing an example of a seventh constitution of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention;

Fig. 11 is a diagram showing an example of an eighth constitution of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention;

Fig. 12 is a diagram comparing the VSWR characteristics of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention with those of a conventional antenna;

Fig. 13 is a diagram comparing the VSWR characteristics of a telephone antenna in a vehicular antenna of an aspect of the embodiment of the present invention with those of a conventional antenna;

Fig. 14 is a cross-sectional view showing the constitution of a conventional vehicular antenna;

Fig. 15 is a diagram showing the constitution of a helical antenna used as a telephone antenna in a conventional vehicular antenna; and

Fig. 16 is a diagram showing the constitution of a top-loaded antenna used as a telephone antenna in a conventional vehicular antenna.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] The constitution of an aspect of the embodiment of a vehicular antenna of the present invention is shown in Fig. 1 (a), (b) through Fig. 3. Fig. 1 (a) is a top view of a vehicular antenna, Fig. 1 (b) is a plan view thereof, Fig. 2 shows a breakout plan view, and Fig. 3 is an oblique view with the cover removed.

[0018] As shown in Fig. 1, a vehicular antenna 1 of the present invention comprises an elliptical conductive metal base 3, and an antenna case, comprising a synthetic plastic cover 2 attached by fitting same together with this metal base 3. As shown in Fig. 2, a flexible pad 8 is arranged on the bottom surface of this metal base 3, and the vehicular antenna 1 is mounted to a vehicle. The vehicular antenna 1 does not have an element or other portion, which protrudes from the antenna case.

[0019] Furthermore, a mounting screw portion 3a is formed in a protruding condition on the back side of the metal base 3. This mounting screw portion 3a is inserted into a mounting hole formed in a vehicle. and mounts the vehicular antenna 1 to the vehicle in a fixed condition by screwing in the mounting screw. In this mounting screw portion 3a, there is provided a through hole, which is a slit formed parallel to the axis of the mounting screw portion 3a, and this through hole is used to guide a GPS cable 10 and a telephone cable 11 into the antenna case from externally.

[0020] The end of the GPS cable is equipped with a connector 10a, which connects to a GPS instrument, and the end of the telephone cable is equipped with a connector 11a, which connects to a car phone.

[0021] As shown in Fig. 2 by breaking out the cover 2 and metal base 3, a GPS antenna portion 4, which receives GPS signals, and a telephone antenna portion 5 for a car phone are stored inside an antenna case. This GPS antenna portion 4 is housed inside a GPS antenna storage portion 3b formed in the metal base 3. And then, the telephone antenna portion 5 is connected electrically, and mounted in a fixed condition mechanically to a matching circuit-embedded circuit board 6, which is shown in Figs. 2, 3. Then, this circuit board 6 is mounted in a fixed condition to the metal base 3. Further, the GPS cable 10, which is guided inside the antenna case, is connected to the GPS antenna portion 4, and the telephone cable 11 is connected to the circuit board 6.

[0022] Furthermore, the GPS antenna storage portion 3b constitutes a shape, in which a frame capable of storing the rectangular-shaped GPS antenna portion 4 is formed with 4 sides, and the GPS antenna portion 4 is stored in this GPS antenna storage portion 3b via a waveform wave spring 4a. And then, although not shown in the figure, when the cover 2 is attached by fitting same together with the metal base 3, the GPS antenna portion 4 is held in place inside the GPS antenna storage portion 3b by pressure applied thereto by a pressure protrusion formed on the inner side of the cover 2.

[0023] Further, when the GPS cable 10 and telephone cable 11 are guided out from the through hole in the mounting screw portion 3a, as shown in Fig. 2, in addition to being pulled out sideways from inside the slit formed parallel to the axis of the mounting screw portion 3a, these cables 10, 11 can also be pulled out perpendicular thereto as indicated by the 2-dot chain line. In accordance therewith, the GPS cable 10 and telephone cable 11 can be pulled out by tailoring same to the structure of the vehicle to which the vehicular antenna is to be mounted.

[0024] The telephone antenna portion 5 comprises an umbrella-shaped top load portion 5a, which is bent downward as shown in the figure, for example, and a linear element 5b, and a matching stub 5e is disposed so as to connect between midway on the element 5b and a ground pattern of the circuit board 6. This matching stub 5e is for achieving matching between the telephone antenna portion 5 and the telephone cable 11, and the top load portion 5a is housed in the semi-spherical bulge portion of the cover 2. Further, as shown in Fig. 2, a T-shaped pin 6a is provided so as to pass through from the back surface of the circuit board 6 and protrude to the front surface, and the element portion 5b, which is formed from a metal pipe, is configured by being fitted together by insertion with the protruding T-shaped pin 6a. Furthermore, the tip of the element portion 5b is fitted by insertion through the through hole disposed roughly in the center of the umbrella-shaped top load portion 5a, and mounted in a fixed condition using solder or the like.

[0025] Various constitutions are possible for the telephone antenna portion 5, and the constitution shown in Fig. 2 and Fig. 3 is one such example. Fig. 4 through Fig. 11 show examples of other constitutions.

[0026] A first example of a constitution of a telephone antenna portion 5 is shown in Fig. 4. Fig. 4 (a) is a top view of a telephone antenna portion 5, and Fig. 4 (b) shows a half section of a plan view thereof.

[0027] As shown in these diagrams, the telephone antenna portion 5 of the first constitution example is constituted from a linear element portion 5b, and a circular top load portion 5a, which is disposed at the end of this element 5b, and which is bent downward so as to form an umbrella shape. A flange-shaped top load mounting portion 5c is formed at the end of the element portion 5b, and the top load portion 5a is mounted in a fixed condition by solder to the top load mounting portion 5c. Further, at the bottom end of the element portion 5b, a flange-shaped mounting portion 5d is formed, and this mounting portion 5d is mounted in a fixed condition by solder to a pattern formed in a circuit board 6. At this time, the element portion 5b is connected to a matching circuit provided on the circuit board 6. Furthermore, when the circuit board 6 is mounted to the metal base 3, the ground pattern of the circuit board 6 is connected electrically to the metal base 3, and the metal base 3 is used as the ground plane for the telephone antenna portion 5.

[0028] Because the top load portion 5a of this telephone antenna portion 5 is bent downward so as to constitute an umbrella shape, the capacity formed between the metal base 3, which constitutes the ground plane, and the top load portion 5a is large, enabling the diameter D2 of the top load portion 5a to be shortened. For example, when this telephone antenna portion 5 is used

as an antenna in a Global System for Mobile Communications (GSM) system, which is one of the digital cellular systems, the diameter D2 of the top load portion 5a becomes roughly 30mm, and the antenna height H1 becomes roughly 25.8mm. By comparison, when a conventional top-loaded antenna 120 of the same antenna height, shown in Fig. 16, is used in a GSM system, the diameter D5 of the top load portion 120a must be 40mm. The size of the diameter of top load portion 5a is thus more than 30 percent smaller. Furthermore, the transmitting frequency of the GSM system is set between 890-915 MHz, and the receiving frequency is set at between 935-960 MHz.

[0029] Next, a second example of a constitution of a telephone antenna portion 5 is shown in Fig. 5. Fig. 5 (a) shows a top view of a telephone antenna portion 5, and Fig. 5 (b) shows a half section of a plan view thereof.

[0030] As shown in these diagrams, the telephone antenna portion 5 of the second constitution example is constituted from a linear element portion 5b, and a circular top load portion 5a, which is disposed at the end of this element 5b. The end of this top load portion 5a is bent downward at roughly a right angle so that the cross-section thereof forms an L shape. Then, a flange-shaped top load mounting portion 5c is formed at the end of the element portion 5b, and the top load portion 5a is mounted in a fixed condition by solder to the top load mounting portion 5c.

Further, at the bottom end of the element portion 5b, a flange-shaped mounting portion 5d is formed, and this mounting portion 5d is mounted in a fixed condition by solder to a pattern formed in a circuit board 6. At this time, the element portion 5b is connected to a matching circuit provided on the circuit board 6. Furthermore, when the circuit board 6 is mounted to the metal base 3, the ground pattern of the circuit board 6 is connected electrically to the metal base 3, and the metal base 3 is used as the ground plane for the telephone antenna portion 5.

[0031] Because the top load portion 5a of this telephone antenna portion 5 is bent downward at roughly a right angle, the capacity formed between the metal base 3, which constitutes the ground plane, and the top load portion 5a is large, enabling the diameter D3 of the top load portion 5a to be shortened. For example, when this telephone antenna portion 5 is used as an antenna in a GSM system, the diameter D3 of the top load portion 5a becomes roughly 30mm, and the antenna height becomes roughly 25.8mm. Therefore, the size of the diameter can be more than 30 percent shorter than that of a conventional top-loaded antenna 120.

[0032] Next, a third example of a constitution of a telephone antenna portion 5, which is an improved version of the second constitution example, is shown in Fig. 6. Fig. 6 (a) shows a top view of a telephone antenna portion 5, and Fig. 6 (b) shows a half section of a plan view thereof.

[0033] As shown in these diagrams, the telephone antenna portion 5 of the third constitution example is constituted from a linear element portion 5b, and a circular top load portion 5a, which is disposed at the end of this element portion 5b. The end of this top load portion 5a is bent downward at roughly a right angle in 2 stages so that the cross-section thereof forms a U shape. Then, a flange-shaped top load mounting portion 5c is formed at the tip of the element portion 5b, and the top load portion 5a is mounted in a fixed condition by solder to the top load mounting portion 5c. Further, at the bottom end of the element portion 5b, a flange-shaped mounting portion 5d is formed, and this mounting portion 5d is mounted in a fixed condition by solder to a pattern formed in a circuit board 6. At this time, the element portion 5b is connected to a matching circuit provided on the circuit board 6. Furthermore, when the circuit board 6 is mounted to the metal base 3, the ground pattern of the circuit board 6 is connected electrically to the metal base 3, and the metal base 3 is used as the ground plane for the telephone antenna portion 5.

[0034] Because the top load portion 5a of this telephone antenna portion 5 is bent downward in 2 stages at roughly right angles, the capacity formed between the metal base 3, which constitutes the ground plane, and the top load portion 5a is large, enabling the diameter D4 of the top load portion 5a to be shortened. For example, when this telephone antenna portion 5 is used as an antenna in a GSM system, the diameter D4 of the top load portion 5a becomes roughly 25mm, and the antenna height becomes roughly 25.8mm. Therefore, the size of the diameter can be roughly 17% shorter than that of the telephone antenna portion 5 of the second constitution example.

[0035] Next, a fourth example of a constitution of a telephone antenna portion 5 is shown in Fig. 7. Fig. 7 (a) shows a top view of a telephone antenna portion 5, and Fig. 7 (b) shows a half section of a plan view thereof.

[0036] As shown in these figures, in the telephone antenna portion 5 of the fourth constitution example, a matching stub 5e is provided on a linear element portion 5b, making matching easy to achieve. One end of this matching stub 5e is connected to a prescribed location of the element portion 5b, and the other end is connected to a ground pattern formed in a circuit board 6. Furthermore, in Fig. 7, the top load portion 5a constitutes a shape, which is bent downward so as to form an umbrella shape, but the shape of the top load portion 5a can be made into a shape, in which the end is bent downward at roughly a right angle (See Fig. 5), or the top load portion 5a can be made into a shape, in which the end is bent downward in 2 stages at roughly right angles (See Fig. 6).

[0037] Next, a fifth example of a constitution of a telephone antenna portion 5 is shown in Fig. 8. Fig. 8 (a) shows a top view of a telephone antenna portion 5, and Fig. 8 (b) shows a half section of a plan view thereof.

[0038] As shown in these figures, in the telephone antenna portion 5 of the fifth constitution example, a con-

tracting coil 5f is inserted into a linear element portion 5b, making it possible to further shorten the length of the element portion 5b. A matching stub 5e is also provided on the element portion 5b, making it easy to achieve matching even though a contracting coil 5f has been inserted. One end of this matching stub 5e is connected to a prescribed location of the element portion 5b, and the other end is connected to a ground pattern formed in a circuit board 6.

[0039] Furthermore, in Fig. 8, the top load portion 5a constitutes a shape, which is bent downward so as to form an umbrella shape, but the shape of the top load portion 5a can be made into a shape, in which the end is bent downward at roughly a right angle (See Fig. 5), or the top load portion 5a can be made into a shape, in which the end is bent downward in 2 stages at roughly right angles (See Fig. 6).

[0040] Next, a sixth example of a constitution of a telephone antenna portion 5 is shown in Fig. 9. Fig. 9 (a) shows a top view of a telephone antenna portion 5, and Fig. 9 (b) shows a half section of a plan view thereof.

[0041] As shown in these figures, in the telephone antenna portion 5 of the sixth constitution example, the top load portion 5a is a skeleton constitution of only the frame thereof. Even when the top load portion 5a is a skeleton constitution like this, the diameter of the top load portion 5a can be made smaller than in the past without the capacity generated between the top load portion 5a and the ground plane being reduced.

[0042] Furthermore, in Fig. 9, the top load portion 5a constitutes a shape, which is bent downward so as to form an umbrella shape, but the shape of the top load portion 5a can be made into a shape, in which the end is bent downward at roughly a right angle (See Fig. 5), or the top load portion 5a can be made into a shape, in which the end is bent downward in 2 stages at roughly right angles (See Fig. 6), and this top load portion 5a can also be made into a skeleton constitution.

[0043] Next, a seventh example of a constitution of a telephone antenna portion 5 is shown in Fig. 10. Fig. 10 (a) shows a top view of a telephone antenna portion 5, and Fig. 10 (b) shows a half section of a plan view thereof.

[0044] As shown in these figures, in the telephone antenna portion 5 of the seventh constitution example, a dielectric 7 fills in the space between the top load portion 5a and the circuit board 6. In accordance therewith, the capacity generated between the top load portion 5a and the ground plane increases in accordance with the dielectric constant of the dielectric 7, enabling the diameter of the top load portion 5a to be made smaller.

[0045] Furthermore, in Fig. 10, the top load portion 5a constitutes a shape, which is bent downward so as to form an umbrella shape, but the shape of the top load portion 5a can be made into a shape, in which the end is bent downward at roughly a right angle (See Fig. 5), or the top load portion 5a can be made into a shape, in which the end is bent downward in 2 stages at roughly right angles (See Fig. 6), and a dielectric 7 can fill in the space between the top load portion 5a and the ground plane. Further, the top load portion 5a can be formed by either depositing a thin film via evaporation onto the surface of the dielectric 7, or by attaching a thin metal sheet to the surface of the dielectric 7 using a viscous substance.

[0046] Next, an eighth example of a constitution of a telephone antenna portion 5 is shown in Fig. 11. Fig. 11 (a) shows a top view of a telephone antenna portion 5, and Fig. 11 (b) shows a half section of a plan view thereof.

As shown in these figures, in the telephone antenna portion 5 of the eighth constitution example, the inside of the dielectric 7, which fills in the space between the top load portion 5a and the circuit board 6, is hollow. Even by so doing, the capacity generated between the top load portion 5a and the ground plane increases in accordance with the dielectric constant of the dielectric 7, enabling the diameter of the top load portion 5a to be made smaller.

[0047] Furthermore, in Fig.II, the top load portion 5a constitutes a shape, which is bent downward so as to form an umbrella shape, but the shape of the top load portion 5a can be made into a shape, in which the end is bent downward at roughly a right angle (See Fig. 5), or the top load portion 5a can be made into a shape, in which the end is bent downward in 2 stages at roughly right angles (See Fig. 6), and a dielectric 7 can fill in the space between the top load portion 5a and the ground plane. Further, the top load portion 5a can be formed by either depositing a thin film via evaporation onto the surface of the dielectric 7, or by attaching a thin metal sheet to the surface of the dielectric 7 using a viscous substance.

[0048] In the thus constituted first constitution example through eighth constitution example, the electrical characteristics of the telephone antenna portion 5 are practically identical. For example, the VSWR frequency characteristics of the telephone antenna portion 5 of the fourth constitution example shown in Fig. 7 are shown in Fig. 12 and Fig. 13.

[0049] Fig. 12 is VSWR characteristics when antenna height is made to exceed $3\lambda/16$ (λ: targeted frequency wavelength), and it was learned that, as indicated by "Present Invention" in Fig. 12, the operable frequency range becomes broadband, making the fourth constitution example well suited for use as a telephone antenna.

[0050] Further, Fig. 13 is VSWR characteristics when antenna height is less than $3\lambda/16$, and it was learned that, as indicated by "Present Invention" in Fig. 13, the frequency range of a 2.0 or less VSWR becomes broadband, making the fourth constitution example well suited for use as a telephone antenna.

[0051] Since the present invention is constituted as described above, a GPS antenna portion and a telephone antenna portion can be housed inside an antenna case, enabling the realization of a vehicular antenna

without a protruding element part, and making it possible to achieve a vehicular antenna, which will not be broken off or bent by an obstacle.

[0052] Further, because the top load portion in the telephone antenna portion is bent downward, the gap between the top load portion and the ground is narrowed, and the capacity resulting from the top load portion and the ground is increased. In accordance therewith, since the diameter of the top load portion can be kept small, the antenna height can be lowered, and the telephone antenna portion can be made compact.

[0053] In this manner, because the vehicular antenna of the present invention makes it possible to house a telephone antenna portion inside a compact antenna case, and enables the overall vehicular antenna to be made compact, design problems are held to the minimum even when same is mounted to a vehicle.

Claims

1. A vehicular antenna, comprising:

   a telephone antenna portion capable of receiving a telephone band;
   a circuit board, which comprises at the least matching means, and to which this telephone antenna portion is mounted in a fixed condition;
   a GPS antenna portion; and
   an antenna case, which comprises a conductive base, and a cover attached by being fitted together with this base, and inside of which is housed said circuit board, to which said telephone antenna portion is mounted in a fixed condition, and said GPS antenna portion,
   and said telephone antenna portion is constituted from a linear element portion, and a top load portion, which is disposed at the end of this element portion, and which is bent downward.

2. The vehicular antenna according to claim 1, wherein said top load portion slopes downward to form an umbrella shape.

3. The vehicular antenna according to claim 1, wherein the end portion of said top load portion is bent one or more times to achieve rough orthogonality.

4. The vehicular antenna according to claim 1, wherein is provided a matching stub, one end of which is connected to a prescribed location of said element portion, and the other end of which is connected to a ground.

5. The vehicular antenna according to claim 1, wherein a contracting coil is inserted into said element portion.

6. The vehicular antenna according to claim 1, wherein said top load portion is a frame-only skeleton constitution.

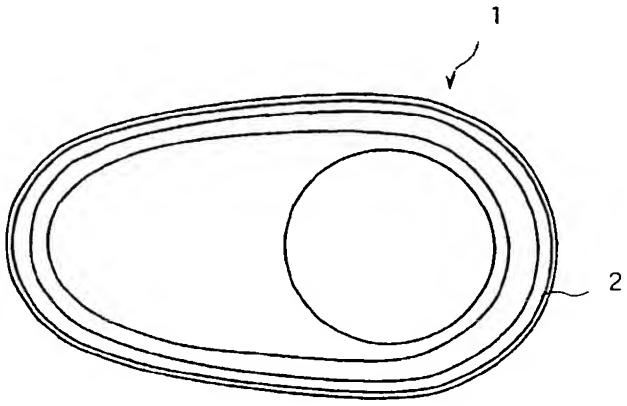


FIG 1(a)

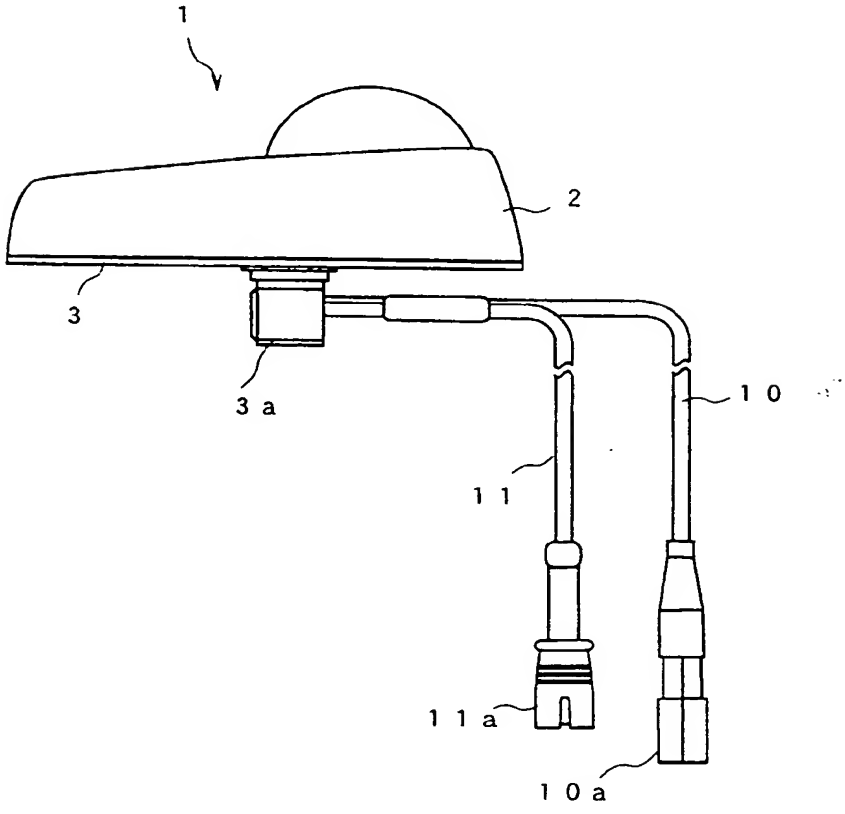


FIG 1. (b)

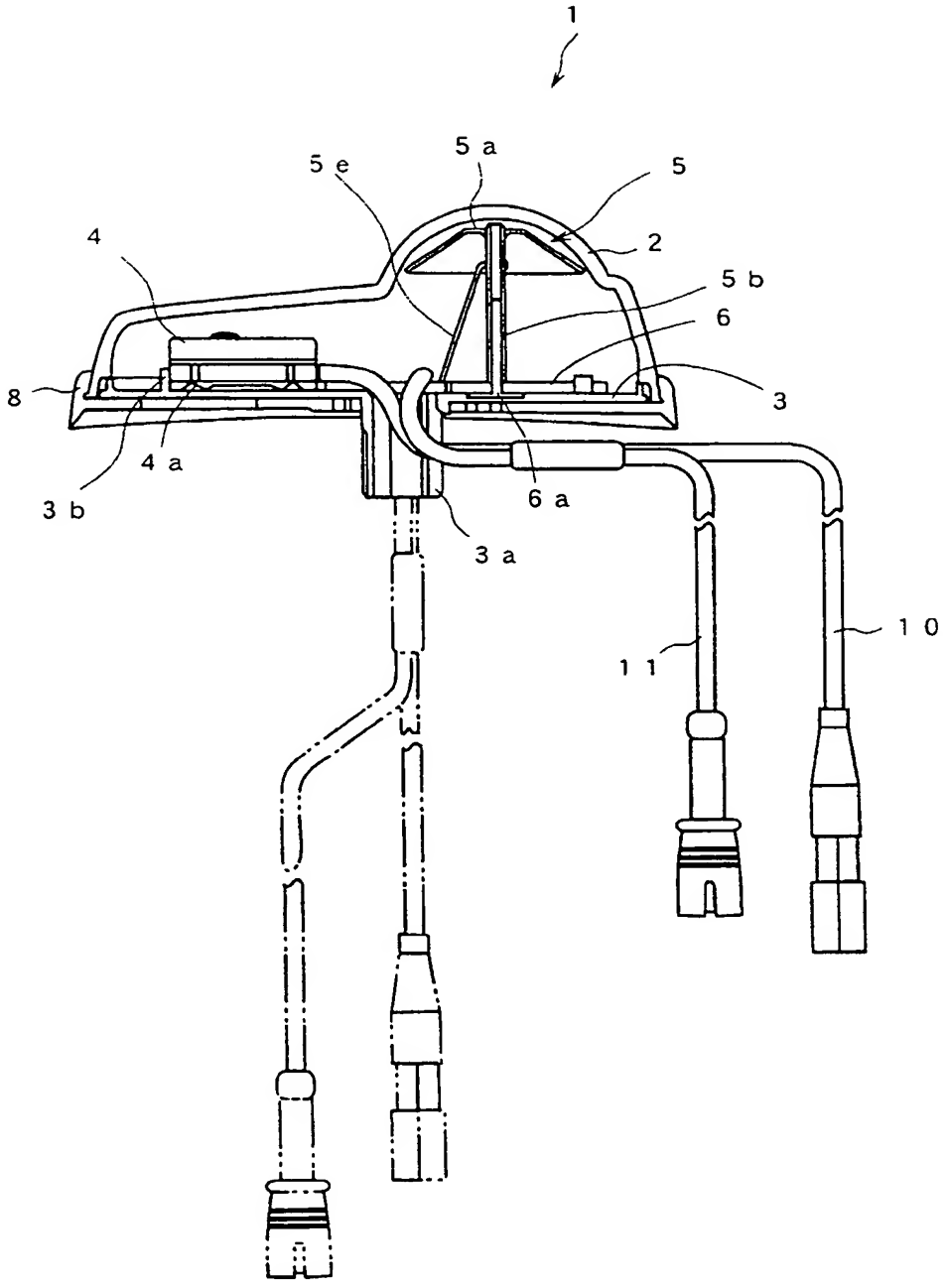


FIG. 2

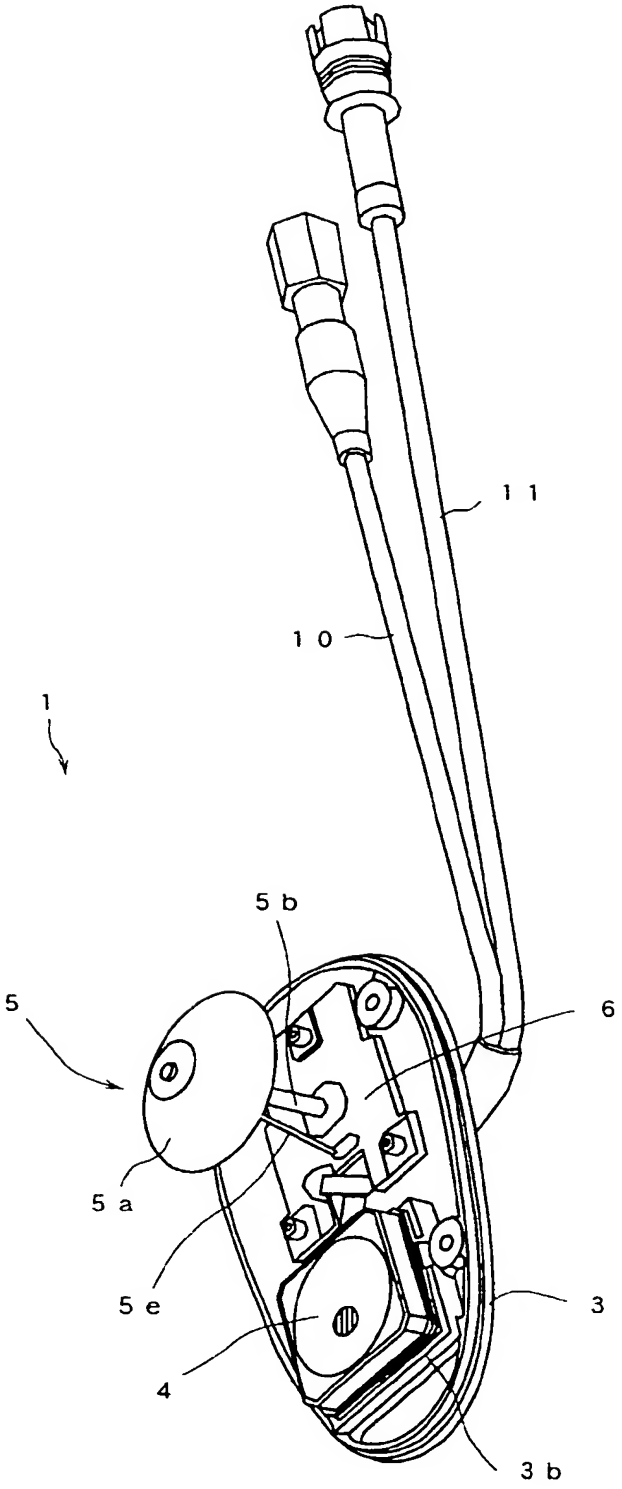


FIG. 3

FIG. 4(a)

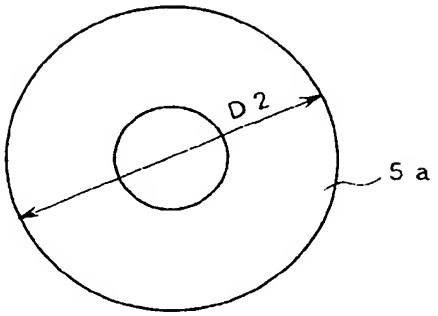


FIG. 4(b)

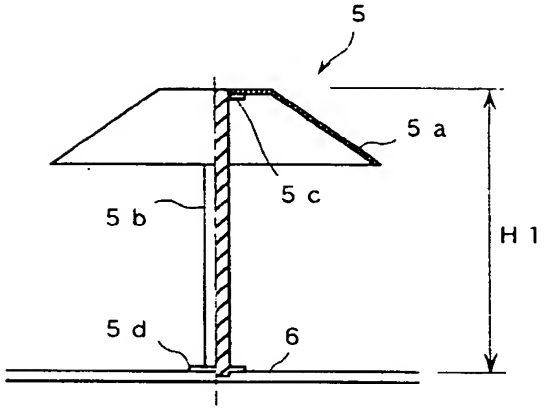


FIG. 5(a)

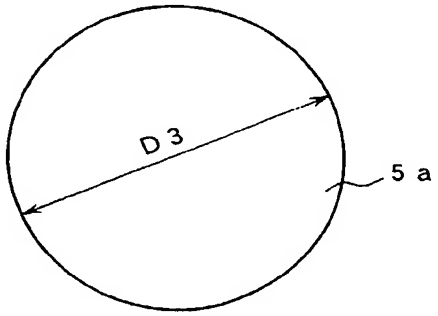


FIG. 5(b)

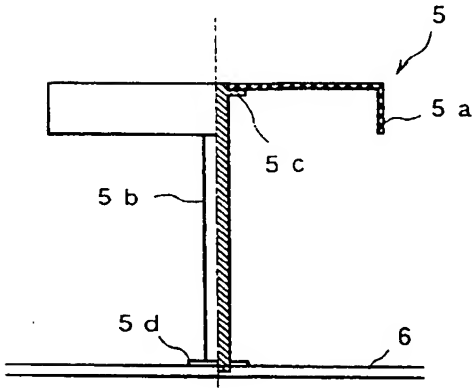


FIG. 6(a)

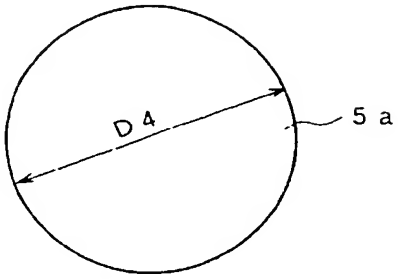


FIG. 6(b)

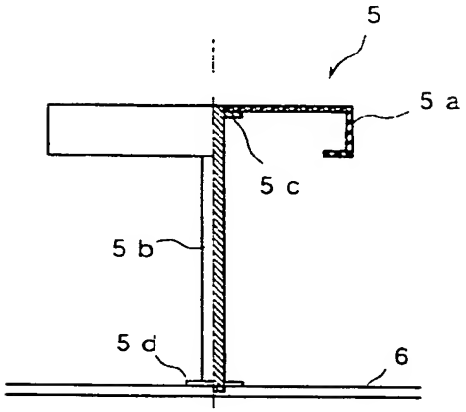


FIG. 7(a)

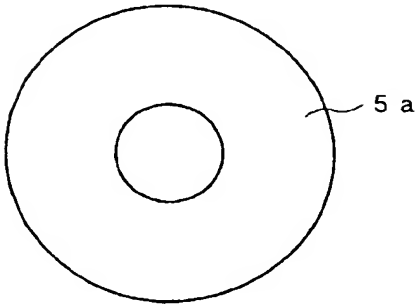


FIG. 7(b)

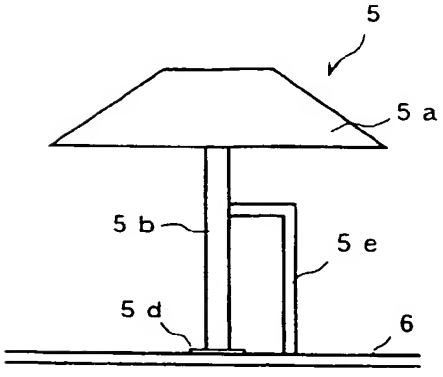


FIG. 8(a)

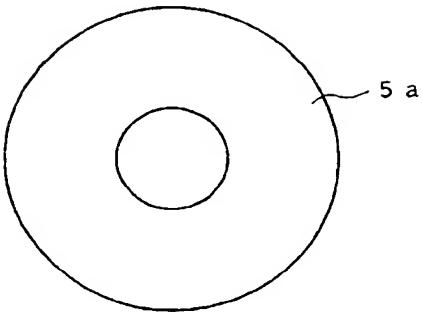


FIG. 8(b)

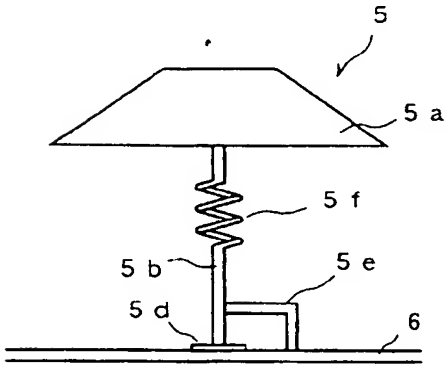


FIG. 9(a)

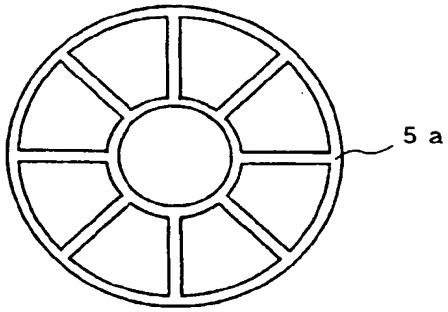


FIG. 9(b)

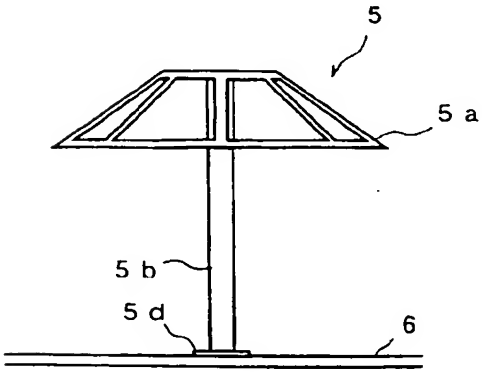


FIG. 10(a)

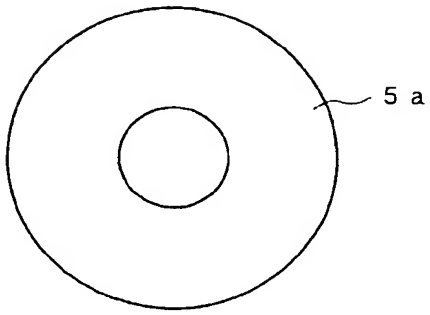


FIG. 10(b)

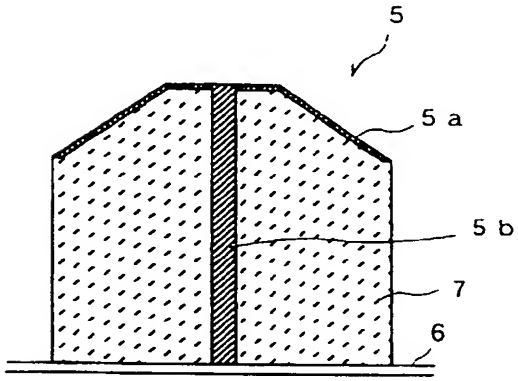


FIG. 11(a)

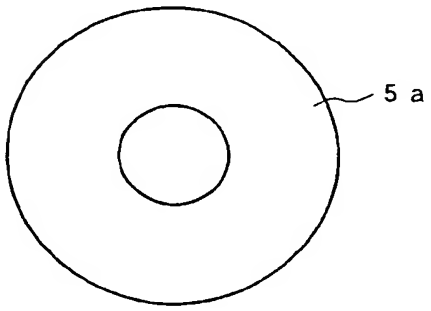
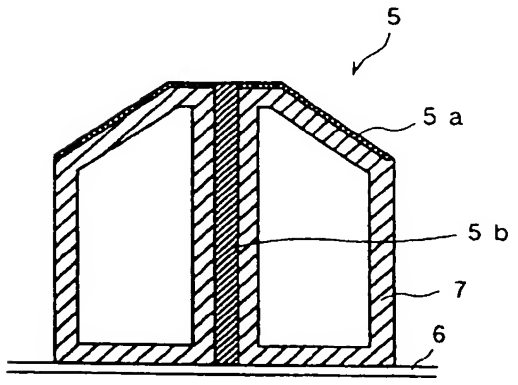


FIG. 11(b)



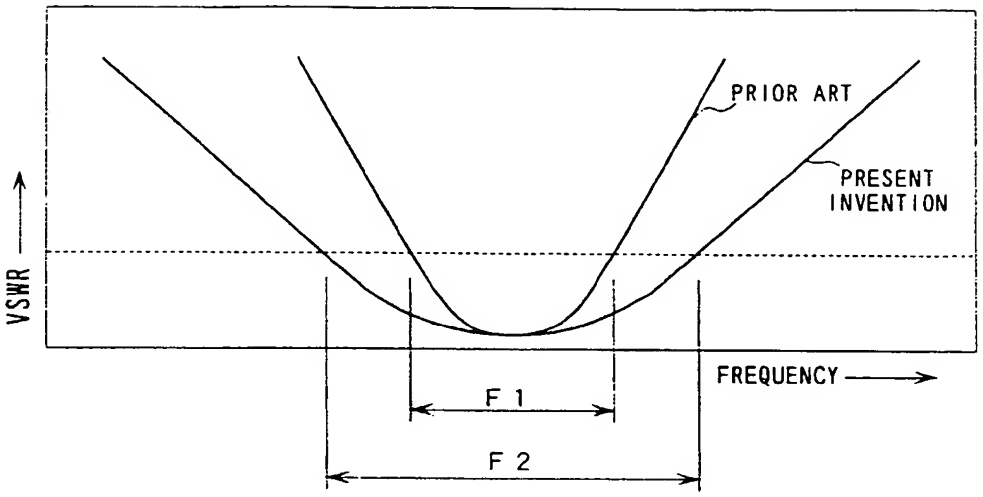


FIG. 12

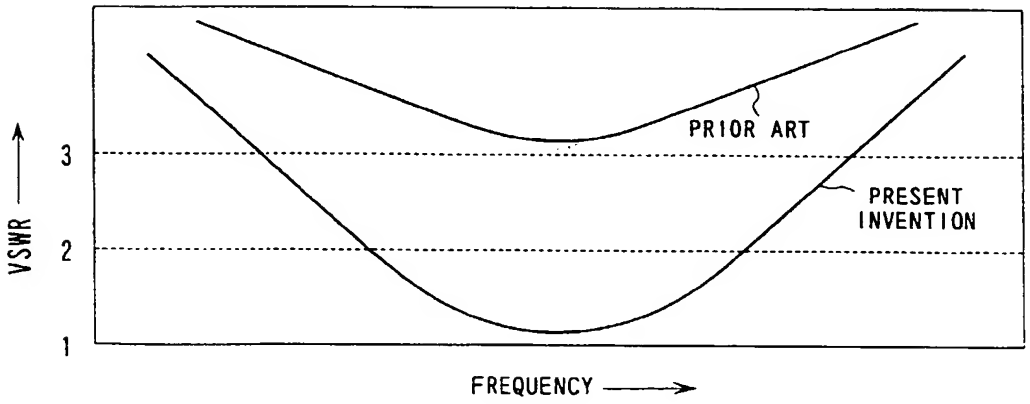


FIG. 13

FIG. 14

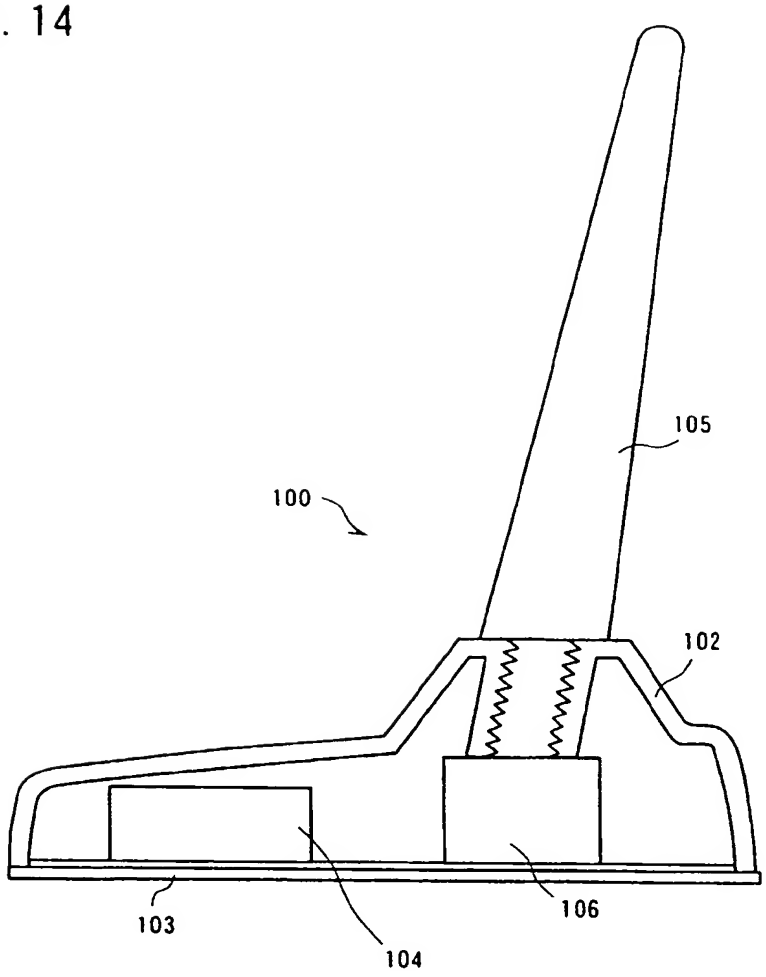


FIG. 15

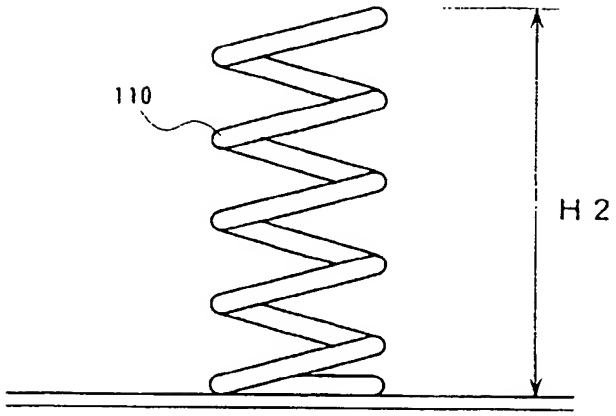


FIG. 16(a)

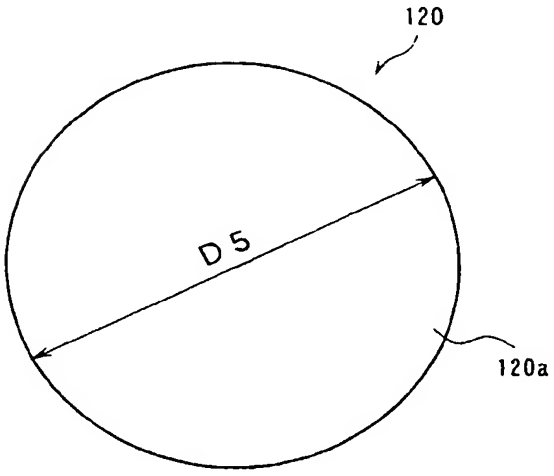
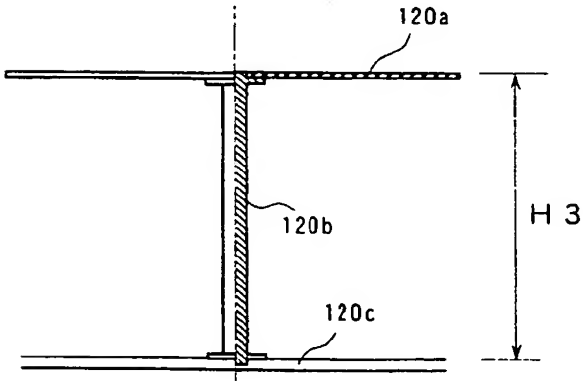


FIG. 16(b)



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 40 2141

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 509 339 A (HAGENUK TELECOM GMBH) 21 October 1992 (1992-10-21) * column 4, line 11 - column 4, line 53; figures 2,3 *	1	H01Q9/36
X	GB 2 282 487 A (MOTOROLA INC) 5 April 1995 (1995-04-05) * page 13, line 3 - page 17, line 7; figures 3,4 *	2	
P,X	GB 2 323 476 A (GANESHMOORTHY DAVID ;GANESHMOORTHY KANDIAH (GB); GANESHMOORTHY RIC) 23 September 1998 (1998-09-23) * page 2, line 19 - page 3, line 5; figure 1 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	2 December 1999	Villafuerte Abrego

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 40 2141

This annex lists the patent family members relating to the patent documents citec in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-12-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0509339 A	21-10-1992	DE 4113277 A	22-10-1992
		AT 119319 T	15-03-1995
		DE 59201497 D	06-04-1995
		DK 509339 T	10-07-1995
		ES 2072042 T	01-07-1995
GB 2282487 A	05-04-1995	US 5708445 A	13-01-1998
		BR 9404303 A	15-06-1999
		CA 2133987 A	15-09-1994
		WO 9421001 A	15-09-1994
GB 2323476 A	23-09-1998	WO 9843313 A	01-10-1998

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82